SEAT BELT WEBBING AND METHOD OF DYEING SAME

BACKGROUND AND SUMMARY OF THE INVENTION

This is a regularly filed utility patent application claiming priority of provisional patent application 60/214,193, filed June 26, 2000.

The invention generally relates to a method of dyeing a particular type of seat belt webbing and more particularly to a method of dyeing the blended hybrid fiber and the seat belt generally identified in United States Patents 5,830,811 and 6,228,488, each of which is incorporated herein by reference. This blended hybrid fiber is of the type known as PET-polycaprolactone diblock copolymer fiber.

The fiber has many uses. One such use is within a woven seat belt (webbing) comprising blended hybrid warp and blended hybrid or PET weft fibers. This particular blended hybrid PET fiber displays high elongation rate as compared to the elongation rate of a typically constructed polyester seat belt webbing whose elongation is in the vicinity of 5-14 percent. In essence, this type of seat belt stretches in a controlled manner, and absorbs energy while stretching, which lowers the chest and head injury levels that are commonly associated with vehicular crashes and used as a measurement of the efficiency of a safety restraint system.

One significant disadvantage of this type of fiber, as well as a seat belt webbing made with this fiber, is that the dyed material is not color fast, light fast, is difficult to dye, and does not retain a soft pliable consistency.

It is an object of the present invention to be able to satisfactorily dye a blended hybrid fiber and more particularly polyester/nylon hybrid seat belt webbing having such fibers.

Accordingly the invention comprises: a process of dying a material including seat belt webbing within a dye range, the material or seat belt comprising a woven polyester and containing blended hybrid PET fibers, the process comprising the steps of: heating the material (webbing) to a preferred range while under tension and subsequently washing, steaming, finish coating and drying the webbing.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 shows a generally known dyeing range and process that is adaptable to dye seat belt webbing using synthetic fibers.

DETAILED DESCRIPTION OF THE INVENTION

The following method of dyeing is particularly suited for dyeing material including seat belt webbing (also referred to as a seat belt or webbing) containing a PET-polycaprolactone diblock copolymer fiber.

The general process of dyeing a woven polyester material, including seat belt webbing, with or without blended hybrid PET fiber uses common machinery and similar process steps. However, it was discovered that simple and subtle changes in known processes surprisingly changed the characteristics of the dyed material (webbing) to an acceptable product. The following shows a prior art process for dyeing blended hybrid fibers; subsequently, the changes to this process are defined. It has been proposed to pass a

PET seat belt (webbing) 10 through a tensioning device to allow constant back tension of the belt prior to the dyeing process. Simply stated, there must be some tension on the belt prior to immersion in the dye pad and pan itself to prevent the webbing from developing fold and crease marks. FIGURE 1 shows a generally known dyeing process that is adaptable to the present invention. The hybrid blend PET seat belt 10 is padded through a dye bath 20 (the dye bath liquid 22 will also be called liquor) potentially including but not limited to dyestuff (most often disperse dyestuff is used for coloring of the belt), acetic acid, dispersant, chelate, water, carrier, UV absorber and wetter (wetting agent). The liquor does not necessarily have all the chemical components, which may vary from process to process, but must have the colorant (dyestuff) to impart a controlled color to the hybrid blend PET seat belt.

The webbing is then passed through a nip point (single or multiple) 24 to squeeze off or otherwise remove the excess dye bath liquor to a relatively consistent amount. The liquor-saturated seat belt is then passed through a heated zone (or pre-drier) 30 with a temperature maintained below 143 C (290 F). At the completion of the heated zone the liquor has been reduced to chemicals not flashed (evaporated off by the heating) and the dyestuff. The seat belt 10 is not dyed at this time but rather weakly stained by the dyestuff.

The seat belt is then passed through a tension device most often called a brake unit 40, which may include a number of rollers and a motor and/or a brake to slow the speed of the rollers. The brake unit can

push or run excess seat belt to an oven 50, which is next in the process flow or can impart excess tension on the seat belt holding back the webbing back from the preferred thermosol oven 50. This action of the brake unit 40 is one part of controlling the elongation characteristics of the material (webbing 10) on the thermosol dye range.

The seat belt now enters the oven 50, the oven for the dyeing process. In this prior method, the thermosol oven is heated to a temperature to allow the seat belt to reach 210 C (410 F). At the 210 C (410 F) temperature the fiber will soften and an attraction between the disperse dyestuff and the polyester will allow the coloring of the webbing to occur. Also at this temperature the softened polyester will be restructured to a new width, thickness, and elongation based on the stretch or over feed of the brake unit 40 and haul unit 60 (the haul unit is further in the process flow and includes for example a motor and rollers). Temperatures of this process are not necessarily absolutely 210 C (410 F). The past practice of dyeing PET seat belt has been in the range of 199 C to 232 C (390 F to 450 F). At temperatures below 199 C (390 F) the PET is very hard to adequately dye and control elongation and at temperatures above 224 C (435 F) the PET tends to weaken and shine.

In the prior process, upon exit of the thermosol oven, the seat belt enters a water quench unit 70, which may be a spray or bath. The water quenching has a twofold purpose of aiding in setting the elongation by flash cooling the seat belt and also begins the washing process. However, in the present invention this step must be eliminated. A drain 72 may also be

provided. The seat belt does not have a 100% affinity for the disperse dyestuff and of the remaining disperse dyestuff 5-15% must be removed to allow the seat belt to be utilized with out fear of failing dye stability or crock tests.

The seat belt next enters the haul unit 60. The haul unit acts in conjunction with the break unit 40 to impart tension on the seat belt. This tension is the means of controlling the elongation of the seat belt webbing. The haul unit is the lead motor on the dye range and is therefore the speed determining step of the dye range.

The seat belt next enters the scour pad 80. In the scour pad the seat belt is exposed to a scour mix. This scour mix can contain soaps, wetters, dispersants, alkali, water, and reducing agents. The scour mix does not have to contain all the mentioned chemicals and typically does not contain all the chemicals at the same time. The seat belt picks up 5-20% by weight of the scour mix from the pad after passing through the scour pad nip 82.

The seat belt next enters a steamer chest. The steamer chest 90 can be used solely to control the dwell time to allow the scour mix appropriate time to penetrate the web and loosen the unfixed dyestuff. The steamer chest can also be used to heat the web/scour mixture to promote the cleaning of the web. The steamer can be used to increase elongation of the web if the steam temperature is in the range of 93 C-104 C (200-220 F).

The seat belt is now washed in a washer 100. This process involves allowing the web to be immersed or sprayed (see 70a) with water in repetitive actions.

Between each action a vacuum 102 extraction of the web or a pinching 104 of the web occurs to force the excess water and unattached dyestuff from the web. This process can be run either hot (typically heated with steam, see heater 106) or cold. Heated washing can increase elongation marginally but will also improve washing efficiency.

The seat belt is now dried. The drying action can be accomplished by steam conduction, infrared drying or heated air convection (numeral 110 shows a dryer). If the seat belt is formed from twisted warp yarn the dyeing process can be completed at this time. If the seat belt is formed from untwisted warp yarn the seat belt may require the additional processes of a protective over-coating and subsequent drying. The drying action is to dry the web to a point of dryness at least equal to the absolute moisture level at ambient atmospheric conditions of at ambient temperature.

The seat belt, if untwisted warp yarn is used, next enters a finish application 120. The finish is typically a compound or mixture including but not limited to a wetter, mineral oil, ester or esters, water, and binders, which is available in differing forms from different manufacturers. The finish is applied to untwisted yarn to protect the yarn in abrasion conditions. The finish acts as a lubricant for the seat belt to reduce friction between the belt and any surface the belt contacts.

The seat belt, if untwisted warp yarn is used and the previously described finish pad step occurs, next enters a final drier 130. The final drier is used to remove all excess moisture, from the belt, to the

absolute moisture level or below the absolute moisture level found at ambient atmospheric conditions. The final drier 130 can be either infrared drying, conductive drying, or convective drying.

The present invention refines the process and procedures to produce a material, including an occupant safety seat belt, of the PET-polycaprolactone diblock copolymer yarn. As a seat belt this product meets federal occupant requirements outlined in FMVSS 209. Attempting to process the PET-polycaprolactone diblock copolymer fiber under standard dye range conditions, such as outlined above, will not produce an acceptable occupant safety seat belt. The belt will be extremely stiff due to the polycaprolactone component of the fiber melting and resetting. The present invention involves the adjustments to the operation of the dye range to allow the webbing to be processed in such a means as to allow a controlled product that meets FMVSS 209 requirements.

The seat belt webbing 10 has the following general characteristics. The belt comprises about 300-440 warp yarn ends of the PET-polycaprolactone diblock copolymer multi-filament fibers. The denier can be in the range of 1000-1500. The end count and denier will vary depending on strength required by the customer. The fill fiber is a conventional polyester used in seat belts having a density of about 15-20 picks per inch depending on pliability desired. The fill yarn denier can vary between 220 to 340 dependent on the desired thickness of the webbing.

The preferred method to produce PET-polycaprolactone diblock copolymer seat belt webbing is as follows: The dye range is modified from industry

accepted PET production setup. The thermosol temperature (see oven 60) is set at 149-167 C (300-330 F) vs. 199-235 C (390-455 F); this gives a maximum exposed operating temperature for the web 10 in the range of about 133-149 C (280-300 F) and preferably 143 C (290 F) (compared to the prior art of 210 (410 F)). To achieve this preferred 290 F temperature the oven can be heated in the range of about 149-167 C (300-330 F). The dye range speed is slowed to allow the material to dwell in the oven (thermosol dwell) to be three-five (3-5) minutes instead of the normally used 3 minutes. The steamer 90 is run with a temperature range of 99-105 C (210-220 F). Preferably the dwell time in the steamer is about 2-4 minutes. The wash boxes 106 are run with temperatures between 60-99 C (140-210 F). The thermosol quench 70 is turned off, which permits the disperse dye that is on the fiber to not be reallocated unevenly prior to the dyeing of the caprolactone component of the fiber in the steamer. The dye range is run with the haul unit 2.5-7.0% faster than the brake unit imparting stretch to the seat belt webbing while in the oven.

The dye range dye mix formulation (applied at 20) is adjusted as follows. A blended aromatic solvent and an organic ester compound such as a monooelate ester carrier is added to the dye bath at 2% by volume. Both a photo stabilizer based on copper complex and a chlorobenzotriazene UV absorber are used in conjunction with the solvent the ester compound. Both UV absorbers can be used up to 5% of the bath dependent on depth of shade and required lightfastness. The dye mix can also contain 20% of a polyester resin fatty acid derivative overcoat.

The scour mix (applied at 30) is a mild surfactant formulation is adjusted as follows. A monooelate esters and organic compound carrier is added to the scour mix at 2% of volume.

The final, water resistant, overcoat (applied at 120) is a perflouroalkylcopolymer emulsion finish.